WASHINGTON
SCIENCE TRENDS

HIGHLIGHTS

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Pure Fluid Amplification -- A New Control Technique

Army scientists have developed and tested a novel system for the control of liquids or gases in motion which they believe represents a fundamental breakthrough having numerous potential applications in science, industry and national defense.

* Principles: Pure fluid amplification describes a class of devices and related systems which use moving fluids as their working substances, but which have no solid moving parts. The basic building block is the pure fluid amplifier, which can be roughly compared to the vacuum tube or transistor in electronic systems.

* Operation: In substance, the amplifier directs a low power stream or streams of gas or liquid against the side of a high power stream. The low power stream, known as the control stream displaces or redirects the main power stream. In effect, the control is done through a lower power level -- the principle of amplification. Since no moving parts are used the technique is known as pure fluid amplification.

  A major factor in this process is that the power stream is not destroyed by the deflecting action; that the main stream retains its integrity regardless of movement involved in control.

* Devices: The devices involved consist simply of a block of metal or heavy plastic material in which passageways--using boundary layer control techniques--have been made. The passageways provide for movement of the main stream and deflection action of control streams on either side. From this, Army scientists have devised systems employing feedback paths, pneumatic flip-flop action and locking "memory" units. The devices employed are of sandwich construction and may be molded, machined, stamped or etched through printed circuit techniques. Units much smaller than a dime have been successfully operated. Cost in production is estimated at less than two-tenths of a cent.

* Limitations: An important limitation of fluid-actuated systems is speed. It is therefore believed that they will never compete with electronic systems for very high speed applications. However, they are much faster than fluid systems with moving parts and should be entirely adequate for many applications, including new computers. Speed of response is said to be adequate for handling signals in the audio frequency band. (Over)

Pure Fluid Amplification (Continued)

* Advantages: A number of advantages are claimed for the fluid system:

Ruggedness - The system consists only of a solid having appropriate passages and a fluid. Inherent simplicity therefore, is expected to make it extremely reliable.

High Temperature Operation: Capability for high temperature applications is said to far exceed any other known amplifying action. It is believed that a properly designed unit could operate at white heat if a refractory material is used for the body, and a stable, non-corrosive gas is used as the fluid.

Other advantages are said to include producibility, low cost, reliability, resistance to environmental extremes, virtually unlimited storage or shelf life and the elimination of maintenance and repair problems.

* Applications:

Army scientists have already successfully developed units which may replace electronic components in certain applications, particularly where speed or long distance is not required. Such units can, according to the Army, perform amplification, feedback, digital computation, analog computation, normal mathematic functions and memory.

The Army also believes that pure fluid amplifying and computing elements will take a place in hydraulic and pneumatic systems similar to the position that the vacuum tube and transistor occupy in the field of electronics. Reliable, low-cost control operations may be established for such fluid-actuated systems as food handling, petroleum and chemical processing, piping natural gas and liquids, hydroelectric generating systems, machine tool control, air conditioning and heat regulation, positioning devices, power steering, air hammers and others.

Examples offered by Army scientists include the ordinary household washing machines where operation and control functions must be performed by a wide variety of timers, clutches, motors, and other mechanical and electrical systems -- all of which could conceivably be replaced by fluid amplification. In this, and other applications, an advantage is said to be the ability to servo large forces at high power with the same force performing the logic or memory functions. Replacement of moving control parts in automatic bowling alley pinsetters, they suggest, might be an early civilian application. Another might be the replacement of valves with moving parts in windshield wipers.

It is believed that such a system would have particular advantages where input may be pneumatic in nature, such as certain sensing devices in aircraft autopilots. In such devices, it is believed, information on air/earth attitude might be transmitted and corrections made without the need for moving mechanical parts or electronic controls. Another suggested field of application is in the control of hydrofoil or ground cushion effect craft.

(R&D by R.E. Bowles, B.M. Horton and R.W. Warren, Diamond Ordnance Fuze Laboratories, U.S. Army, Washington 25, D.C.)

Army Modernization Requirements

Here, in order of priority, is a summary of new and replacement items which the Army feels are necessary for modernization programs. These items will be procured if additional funds are voted by Congress and released by the Bureau of the Budget.

Item	Quantity	Cost (in millions)
New rifle using NATO round	120,000	$14.0
NATO round for new rifle and machinegun	200,000,000	18.4
New armored personnel carrier	600	17.7
New fully mobile division artillery howitzers	55	5.3
New extended range ammunition for division artillery howitzers	[1] 551,000	25.9
New fully mobile long-range gun (175 mm.)	115	16.8
Ammunition for the new long-range gun (175 mm.)	[1] 250,000	23.5
Main battle tank	300	45.0
Ammunition for new main battle tank	[1] 59,400	11.0
New infrared fire control for main battle tank for night-fighting capability	2,040	20.0
Mohawk battlefield surveillance aircraft	6	4.7
New Iroquois transport and medical evacuation helicopter	62	20.2
All weather automatic navigation instruments for army aircraft	53	7.9
Battlefield medium troop and cargo transport helicopter	74	15.0
Expedite availability of PERSHING missile system		17.1
Expansion of HAWK missile deployment		8.6
Expedite availability of REDEYE surface-to-air missiles	1,200	7.8
Expansion of LACROSSE surface-to-surface missile deployment	[2] 4	46.3
Expedite availability of LITTLE JOHN surface-to-surface missiles	600	4.8
Expedite availability of SERGEANT surface-to-surface missiles	50	20.2
Expedite availability of HONEST JOHN surface-to-surface missiles including warheads	701	17.5
DAVY CROCKETT rockets	6,247	6.5
New anti-tank missile and launcher	4,233	7.2
Latest improvement for the NIKE-HERCULES		44.7
GOERS, large-capacity cross-country transport vehicles	300	7.0
New mobile light support weapon (81-mm.)	60	2.4
Ammunition for the new light support weapon and other 81-mm. weapons	[1] 807,000	25.2
Caribou battlefield transport aircraft	36	$21.3
New Armored command and reconnaissance vehicle	250	8.4
New light combat recovery and repair vehicle	190	19.4
New light infantry shoulder-fired assault rocket	775,000	22.5
New amphibious arctic personnel and cargo carrier	137	6.1
New field Army mobile air defense fire direction system		40.7
New chemical rocket (115-mm.) and multiple launchers	13,000	3.5
New combat surveillance drones	310	23.8
Radar flight-control systems for drones and aircraft	19	6.7
Division-corps forward area communications		36.7
Seminole combat command and control airplane	19	2.9
Aerial crane (helicopter)	6	12.5
New electronic countermeasure for jamming enemy artillery fuzes	45	3.8
Chinook battlefield heavy troop and cargo transport helicopter	6	9.0
New tank transporter	240	16.8
New over-the-beach combat transporter	534	25.3
New shoulder-fired grenade launchers	3,600	6.7
Forward area tactical vehicle FM command radio	3,331	21.7
Tactical generators for combat and missile units	4,671	5.6
New battlefield mine detecting and clearing devices	1,115	5.6
Field artillery fire control instruments	3,400	3.8
Tactical wheeled vehicles from ¼- to 10-ton capacities	16,445	99.7
New 90-mm. recoilless rifle	1,000	2.4
Ammunition for the new recoilless rifle (90 mm.)	[1] 280,000	16.8
Battlefield intelligence analyzer		18.5
Rolling fluid transporter	945	4.8
Ammunition for artillery weapons and chemical mines	335,000	22.3
Total		928.0

[1] Rounds.
[2] Battalion sets.

Research Checklist

( ) Oscillograph Record Camera: A Navy-built oscillograph record camera is said to show promise of many applications in scientific laboratories and in industry. The camera was first used in the simultaneous recording of all echo-ranging data between two submarines. Information was recorded on 35-mm. film moving at three inches per second from a daylight loading 2,000-foot magazine. Footage is recorded on an external, resettable counter. In the submarine tests a continuous chart was produced showing three sets of data; amplitude of the outgoing signal fed to the echo-ranging transducers, the amplitude of the returning echo, and the amplitude of the incident "ping" as received at one submarine from the projector of the other.

(R&D by Photo-Optical Techniques Branch, U.S. Navy Underwater Sound Laboratory)

( ) Liquid Hydrogen Refrigerator: The Cyrogenic Engineering Laboratory of the National Bureau of Standards has developed an automatic 300-watt capacity, closed circuit, hydrogen refrigeration system said to be flexible enough to be applied to other experimental installations of various sizes. The unit is said to maintain liquid hydrogen temperatures for as long as three months at a time, and is said to be safer and more efficient than a hydrogen liquefier remotely located.

(Details and plans available. 39 pages. 75 cents. Write OTS, U.S. Department of Commerce, Washington 25, D.C. for NBS Technical Note No. 38)

( ) New Army Generator Set: Army has completed tests of its improved 5kw, 60 cycle generator set which is said to be smaller and more compact than the set presently in military use. The 468-pound unit is powered by an air-cooled gasoline engine and is designed for use under severe environmental conditions. A simple reconnecting device permits production of four kinds of electric service; 120 volt, 1 phase, 2 wire; 120/240 volt, 1 phase, 3 wire; 120 volt, 3 phase, 3 wire; or 120/208 volt, 3 phase, 4 wire. Power is said to be of the quality needed for operation of communication, surveillance, and missile systems.

(Reported by U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va.)

( ) Radioactive Fish Tags: A low-level radioactive metal tag will be used by the Interior Department to aid in the studies of fish migration. Tags are made of Alnico V, a highly magnetic metal so that they will be picked up by an electromagnet in the production line of fish processing plants. Special detecting equipment will also be employed to spot tagged fish as they move along the line. In the past, considerable biological data on fish migration has been lost because of the difficulty of recovering conventional tags.

( ) Uranium Dioxide Research: National Aeronautics and Space Administration is investigating materials for high temperature nuclear reactors proposed for rockets, ramjets, turbojets and electrical powerplants. It has been found that hafnium carbide, tantalum nitride and tungsten and tantalum are compatible with uranium dioxide for such applications to a 5000° F melting point.

(Report Available. Single Copies Free. Write National Aeronautics and Space Administration, Attn: Code BID, 1520 H Street, N.W. Washington 25, D.C. for NASA Technical Note D-262)

( ) Industrial Diamond Recovery: The Army has developed an improved process for the reclamation of industrial diamonds from machine wiping cloths, with recoveries of 95 to 99 percent reported. The method is said to be less costly in terms of materials and labor, and to be much safer than the conventional acid or alkali recovery treatments.

(Details Available. 11 Pages. 50 Cents. Write OTS, U.S. Department of Commerce, Washington 25, D.C. for PB 161 121)

( ) Earth Crust Communications: Air Force has signed a $116,000 contract for studies and experiments in sub-surface propagation of electromagnetic waves for long-range communications. Short-range tests in desert locations are said to have established the feasibility of such a system, which is said to have the advantage of excellent survival potential against natural and artificial hazards. Study will survey coupling mechanisms, possible interference from sources above the surface and other related problems.

(R&D by Space Electronics Corp., Glendale, Calif. for Rome Air Development Center, Griffis Air Force Base, New York)

( ) Improved Casting Techniques: Studies sponsored by the Army indicate that vibrating certain metals through ultrasonic or sonic techniques as they solidify in a mold may bring improved strength, hardness and ductility to castings. This is said to be brought about by reducing the size and increasing the number of grains. It is believed that the application of ultra-sonic vibrations to refining grain size in brass may have commercial possibilities since this metal is not readily refined by other methods.

(R&D directed by John F. Wallace, Associate Professor of Metallurgical Engineering, Case Institute of Technology, Cleveland 6, Ohio)

( ) Coal-Hydrogenation Plant: The U.S. Bureau of Mines has now made available technical details of the coal-hydrogenation works at Most, Czechoslovakia which converted coal to liquid fuel for the German Army during World War II. Information is also included on modifications of the plant to use tars as raw material.

(Report can be inspected at Department of Interior Library, Washington, D. C. and Bureau libraries in Pittsburgh, Morgantown, Grand Forks, Denver and Minneapolis)

- Publication Checklist -

( ) Isotope Information, a revised version of a useful government publication listing more than 300 informational reference sources and their availability. The field of isotopes is broken down into 14 major areas of interest. 51 pages. Free. (Write Office of Isotopes Development, U.S. Atomic Energy Commission, Washington 25, D.C. for Publication TID-4563, Special Sources of Information on Isotopes)

( ) Congress and Atomic Energy, a listing of the membership, legislation authorized and publications printed of the Joint Committee on Atomic Energy. 19 Pages. Single Copies Free. (Write Joint Committee on Atomic Energy, F-88, The Capitol, Washington 25, D.C. for Membership, Legislation and Publications Through 86th Congress, 1st Session.)

( ) Heliport Design, a new guide prepared by the Federal Aviation Agency on the design of various kinds of heliports needed for small or large helicopters and service usage. Tells how to obtain technical assistance when required. 30 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Heliport Design Guide.)

( ) Molybdenum Casting Development, a government report describing the successful arc casting of molybdenum into static or centrifugal molds, a process thought to be a milestone in metallurgical development. 16 pages. Single Copies Free. (Write Publications-Distribution Section, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Report of Investigation No. 5555.)

( ) Chemical Processing of Irradiated Fuels, the proceedings of an AEC sponsored symposium held at Richland, Washington Oct. 20-21, 1959 on chemical processing of irradiated fuels for power, test, and research reactors. Includes reports on many activities in this field. 435 Pages. $4.50. (Write OTS, U.S. Department of Commerce, Washington 25, D.C. for Publication TID-7583.)

( ) Scientific and Technical Manpower, an extensive survey and report on the problem of establishing a national program of collection, tabulation and analysis of data for a national register of scientific and technical personnel. 71 pages. Single Copies Free. (Write Committee on Science and Astronautics, U.S. House of Representatives, Washington 25, D.C. for Report-Scientific Manpower.)

( ) Ablation Shields, an extensive mathematical analysis of the problems involved in designing an ablation shield for the reentry of manned space vehicles into the earth's atmosphere. 58 pages. Single Copies Free. (Write National Aeronautics and Space Administration, Attn: Code BID, 1520 H Street, N.W., Washington 25, D.C. for NASA Technical Report No. R-62.)

( ) Semiconductors for Thermoelectric Use, a bibliography containing nearly 150 abstracts of articles and publications appearing between 1950 and 1958. 28 Pages. 25 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for U.S. Bureau of Mines Information Circular No. 7910.)